WHAT IS CLAIMED IS:

1. A method for selectively functionalizing carbon nanotubes comprising:

a) suspending a plurality of carbon nanotubes in a solvent; and

b) reacting a substoichiometric amount of a functionalizing species with the suspended carbon nanotubes such that a portion of the carbon nanotubes react preferentially with the functionalizing species based on the electronic properties of the carbon nanotubes comprising said portion.

2. A method for selectively functionalizing carbon nanotubes comprising:

b) suspending a plurality of carbon nanotubes in a solvent; and

c) reacting a substoichiometric amount of a diazonium species with the suspended carbon nanotubes such that a portion of the carbon nanotubes react preferentially with the diazonium species based on the electronic properties of the carbon nanotubes comprising said portion.

3. A method for selectively functionalizing carbon nanotubes comprising:

a) adding a plurality of carbon nanotubes to an aqueous surfactant solution and homogenizing to form a mixture of surfactant-suspended carbon nanotubes; and

b) reacting a substoichiometric amount of a diazonium species with the surfactant-suspended carbon nanotubes such that a portion of the carbon nanotubes react preferentially with said diazonium species based on the electronic properties of the carbon nanotubes comprising said portion.

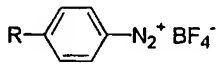
4. The method of Claims 1,2 or 3, wherein the carbon nanotubes are selected from the group consisting of single-wall carbon nanotubes, multi-wall carbon nanotubes, double-wall carbon nanotubes, and combinations thereof.

5. The method of Claims 1,2 or 3, wherein the carbon nanotubes are single-wall carbon nanotubes.

6. The method of Claim 3, wherein the surfactant is selected from the group consisting of ionic surfactants, non-ionic surfactants, cationic surfactants, anionic surfactants, sodium dodecyl sulfate (SDS), sodium dodecylbenzene sulfonate (SDBS), sodium octylbenzene sulfonate, TRITON X-100, TRITON X-405, dodecyltrimethylammonium bromide (DTAB), and combinations thereof.

7. The method of Claims 2-5 or 6, wherein the diazonium species is an aryl diazonium salt.

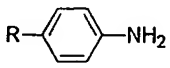
8. The method of Claim 7, wherein the aryl diazonium salt comprises:



and wherein R is selected from the group consisting of halogen, nitro, cyano, alkyl, aryl, arylalkyl, OH, carboxylic ester, carboxylic acid, thiocarbonate, amide, alkoxy, polyether, polyalkyl, hydroxy alkyl, and combinations thereof.

9. The method of Claims 2-5 or 6, wherein the diazonium species is generated *in situ* by reacting a substituted aniline species with an alkyl nitrite.

10. The method of Claim 9, wherein the substituted aniline species has a general formula



where R (the substituent, or substituents in the case of multiple substitutions) is selected from the group consisting of halogen, nitro, cyano, alkyl, aryl, arylalkyl, OH,

carboxylic ester, carboxylic acid, thiocarbonate, amide, alkoxy, polyether, polyalkyl, hydroxyl alkyl, and combinations thereof.

11. The method of Claim 8 or 10, wherein R is OH.

12. The method of Claims 1-10, or 11 further comprising a step of thermal defunctionalization to regenerate separated, unfunctionalized carbon nanotubes.

13. A method for separating carbon nanotubes on the basis of their electronic bandgap comprising:

a) selectively functionalizing carbon nanotubes according to the method of Claim 1; and

b) separating the functionalized carbon nanotubes from the unfunctionalized carbon nanotubes.

14. A method for separating carbon nanotubes on the basis of their electronic bandgap comprising:

a) functionalizing carbon nanotubes according to the method of Claim 10 to yield a mixture of selectively-functionalized surfactant-suspended carbon nanotubes, wherein a portion of the carbon nanotubes within the mixture have been selectively-functionalized to bear OH groups, and wherein a portion of the carbon nanotubes within the mixture remain unfunctionalized;

b) deprotonating the OH groups present in the mixture of selectively-functionalized surfactant-suspended carbon nanotubes by increasing pH; and

c) separating the functionalized carbon nanotubes from the unfunctionalized carbon nanotubes.

15. The method of Claim 13 or 14, wherein the functionalized carbon nanotubes are separated from the unfunctionalized carbon nanotubes via electrophoresis.

16. The method of Claim 14, wherein metallic and semi-metallic carbon nanotubes are selectively-functionalized, and wherein semiconducting carbon nanotubes remain unfunctionalized.

17. The method of Claims 14-15 or 16, wherein the step of deprotonating involves raising the pH above 10.

18. The method of Claims 15-16, or 17, wherein the electrophoretic means is selected from the group consisting of gel electrophoresis, capillary electrophoresis, and combinations thereof.

19. The method of Claims 13-17 or 18 further comprising a thermal defunctionalization step to regenerate separated, unfunctionalized carbon nanotubes.

20. A composition of functionalized carbon nanotubes of specific electronic type, made by the method of Claims 13-14, or 15.

21. The composition of Claim 20, wherein the specific electronic type is selected from the group consisting of metallic, semi-metallic, and semiconducting.

22. The composition of Claim 20 or 21, wherein the selective functionalization yields functionalized carbon nanotubes with an extent of functionalization that ranges from about 0.01 to about 0.2 functional groups per nanotube carbon.

23. A composition of carbon nanotubes of specific electronic type, made by the method of Claim 19.

24. The composition of Claim 23, wherein the specific electronic type is selected from the group consisting of metallic, semi-metallic, and semiconducting.